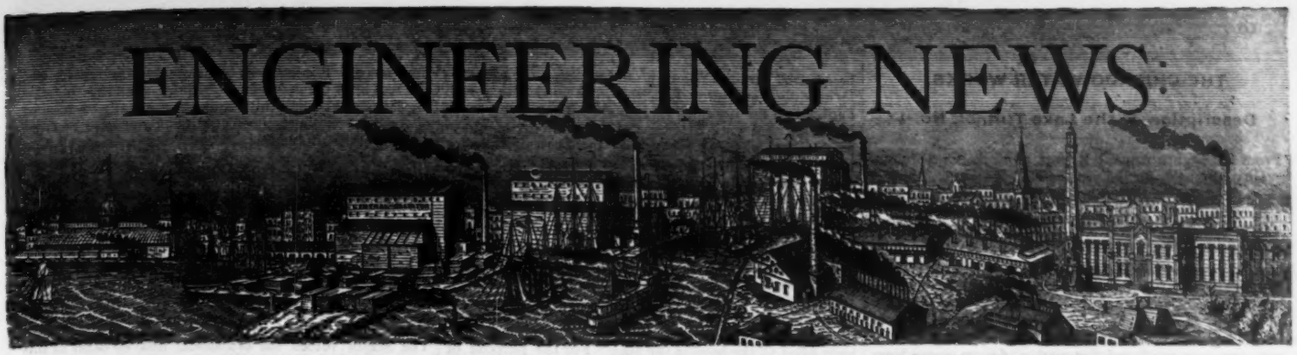
ENGINEERING NEWS.



A WEEKLY JOURNAL OF ENGINEERING, MINING, MANUFACTURES, AND GENERAL SCIENCE.

Vol. III.—No. 3 CHICAGO, SATURDAY, JANUARY 15, 1876. Subscription $2.12 per year Single copies, 6 cents

Chicago River and Harbor.

The river improvements made in the past year have not been so extensive as in previous seasons, more attention being given to the extension of the outer harbor. The following shows the total amount of harbor and dockage, calculated in linear feet, now in existence:

From the lake to the intersection of the North Branch—Harbor, 7,000; dockage, 14.000.

South Branch—Harbor, 21,500; dockage, 43,500.

North Branch—Harbor, 24,000; dockage, 49,500.

Slips and Basins—Harbor, 37,150; dockage, 74,300.

West Branch of the South Branch—Harbor, 17,100; dockage, 34,200.

South Branch of the South Branch—Harbor, 9,300; dockage, 18,600.

Total amount of harborage, 115,550 feet, equal to 21 miles.

Total amount of dockage, 231,100 feet, equal to 43 miles.

One hundred and nine thousand fifty-six dollars and sixty four cents was the sum available July 1, 1875 for harbor improvements. The south end of the breakwater is now 3,280 feet from the shore line of the Illinois Central breakwater, and stands in about 20 feet of water. The new work, designed to protect the face of the outer breakwater, which consists of several tiers of closely driven piles, has progressed quite favorably. The completion of this work will preclude the possibility of the cribs or outer superstructure being damaged by any vessel which may run afoul of the breakwater during a storm. The superstructure of the main pier is now completed for the entire length, and the work of continuing the north pier improvements is being vigorously prosecuted. It is thought that the extension of the north pier will have the benficial effect of giving a quiet and safe anchorage to vessels in the outer basin. Efforts have recently been made to compel all vessels not under charter to occupy the outer basin exclusively, but the success attending them has not been very flattering. However, the projector of this plan yet hopes to induce mariners to appreciate the superior advantages of the roadstead especially provided for them, and ihe absolnte necessity of relieving the Chicago River of the mass of idle shipping which interferes so materially with its free use. The depths have been increased in the outer basin by private dredging. There has been a little shoaling in the main channel opposite the light house, due to sand sifted in from the outside. It forms no obstruction to the main channel as yet, but it is thought best to dredge the shore to the extent of about 25,000 cubic feet, at an expense of $5,000. North of the north pier the shore line has slightly advanced, and there is evidence that the beach for some distance north of the north pier is shoaling gradually.

The following is the extent of improvements during ihe past year, both on docks and in dredging. An unusual amount of dock repairing has been accomplished:

	Cost.
Dock built, 4,666 feet	$ 40,455
Dredging, 342,179 cubic yards	123,184
Total cost	$163,369

Car-Wheels.

The Washburn Car-Wheel Company of Hartford, Conn. are doing a large business in the manufacture of steel-tired car-wheels.

They are made with a rolled and hammered steel tire and a cast-iron body completely welded together in the casting. The wheels are turned in a lathe after being cast, and can be returned whenever the tread becomes uneven by use. The wheel has been so perfected, that, in strength, safety, durability, and economy, far exceeds any wheel now made in this country. The comparative merits of the ordinary chilled wheel in use on most roads, and of the steel-tired wheels made by this company, will appear from an account given by Mr. W. E. Chamberlain, master-car-builder on the Boston and Albany R. R. where over 300 steel-tired wheels are now running under passenger cars; the account also includes about 2200 chilled-iron wheels made by different makers. The mileage is from the time the wheels were put on the road until they were worn out. The total number of miles run by the above number of chilled wheels was 74,529,158; the average number of miles run per wheel, being 33,815. Of the steel-tired wheels above referred to, 570 have already run an average of over 142,282 miles before turning, and are still running.

Only 16 wheels have been turned, and 4 of these after being turned 3 times, have made the extraordinary total run from the time they commenced running, of 440,000 miles, and are running at present. These wheels are still running under the passenger cars of New York and Boston Express line, and are being placed under the engines, tenders, and cars of both the Boston and Albany, and New York, New Haven, and Hartford roads. The first cost of these wheels is nearly double that of chilled wheels, being $50 for 33 inch diameter, $47 for 28 and 30 inch, and $45 for 26 inch, but as they will run so much longer it is cheaper for railroad companies to adopt this wheel.

It is the invention of Nathan Washburn, formerly of Worcester, Mass., for years well known throughout the country as a manufacturer of car-wecels. There is no doubt but that it will be adopted by all the leading railroad companies.

SELECTED LIST OF PATENTS

For the week ending January 1st, 1876.

Relating to Mining, Metallurgy, Engineering, &c., reported for ENGINEERING NEWS by Louis Bagger & Co., Solicitors of Patents, Washington, D. C.

171,321. Metallurgical Furnaces, E. Savage, West Meridan, Conn.

A flue extends from the first combustion-chamber through the second combustion-chamber to the smelting-chamber. A second air-flue passes through the walls of the furnace, and opens, by perforations into the second combustion-chamber below the hearth of the smelting-chamber. The products of combustion which pass to the smelting-chamber are principally carbonic oxide, and are fully burned in the second combustion-chamber, whereby the hearth and flue are heated.

171,380. Rotary Dredgers, A. Hawley, Galveston, Tex.

A dredging machine having a rotary boring-wheel with peripheral brackets and radial knives, said wheel advancing in the line of its axis, and cutting its way by means of the knives. The wheel has vertically adjustable bearings, and can be raised or lowered by the engine through gearing connections.

171,441. Blasting Cartridges, Friend W. Smith, Bridgeport, Conn.

A blasting cartridge formed of a tube of paper, muslin or other suitable material, and having its bottom held in place by means of a solid plug forced in from the inside, and an exterior cup.

171,454. Rolls for Rolling Iron, J. H. Webster, St. Louis, Mo.

The weight causes the beam to partially support the roll on its being raised by the insertion of the iron.

171,460. Car-Dumping Apparatus, Jeremiah Wiland, St. Myrondale, Pa.

A section in the track has rails on the lower and upper sides. The frame is provided with means for holding a car on said track, which by half revolutions tilts the full car down to empty, and at the same time bring the previously emptied car to the upper side for reloading.

171,371. Coke Ovens, Emil S. Gabiet, Mabrich Osteran, Austria.

The products of the combustion of the coke pass from the upper part of each oven through a horizontal series of flues into two similar sets of flues, in the farther side of the oven from the chimney. Each of these flues begins at the center of the side, goes to the end, returns below to the middle, joins to horizontal flues leading to a bottom flue, which leads from the center to end of oven, and returns to center. Thence the products pass through two horizontal flues to the side of the oven, nearer the stack, up it (as on the other side they decended into a vertical flue at the center of the side) and finally into the main oven and flue, connecting with the chimney.

171,409. Gas Metres, Jas. Morgan, New Orleans, La.

A pendulum stop is suspended in the rear of the case, which if the meter be "tilted" swings forward and engages lugs projecting from the drum, and stops the meter and the flow of gas.

171,363. Condensers for Illuminating Gas, G. W. Edge, Jersey City, N. J.

The wheels constructed with the radial spiral vanes, and arranged transversly within, and completely spanning the diameter of, the pipes leading from the retort to the purifiers, as shown and described, to admit of their rotation by the force of the current of gas, as shown and described.

SCIENTIFIC SOCIETIES.

We have devoted considerable space this week to the report of the annual meeting of the Academy of Sciences of this city, which was held on Tuesday evening last. The list of donors to the museum will be published in our next, and we call the attention of all persons interested in general science to the fact that we intend to report as fully as possible the monthly meetings of this and kindred societies of Chicago, and will also publish the proceedings of similar societies in other cities where they do not require too much space. We will be obliged if Secretaries of such will send us the names of their societies, and their place and date of meeting, also an abstract of the minutes of each meeting, as soon after it has been held as possible. We also desire to call the attention of societies to our very liberal club rates, and hope soon to be able to add a large number of their members to our list of subscribers.

Narrow Guage Railways.

CARBONDALE, LUZERNE CO., PA.,
January 10, 1876.

EDITOR NEWS:—In your issue of 8th instant your statement regarding narrow guage railroads, without explanation might be misconstrued. The D., L. & W. R. R. has a six foot track, and proposes to alter it to a 4′ 8½, which is considered here the standard guage. What is understood as narrow guage here is only 3 feet of which we have several.

Yours very respectfully.

BRYCE P. BLAIR.

THE CHICAGO WATER WORKS.

Description of the Lake Tunnel, No. 1

From the Eighth Annual Report of E. S. Chesbrough, City Engineer, for the year ending March 31, 1869.

[CONCLUDED.]

INSPECTORS.

As the contractors did not deem it important to employ Mr. Bramhall after the lake shaft was sunk, the Board, highly appreciating his skill and industry, engaged him to perform similar duties to those of Mr. Kroeschell, in tunnelling from this shaft. Four different inspectors of masonry were employed, but neither of them stayed long. One of them, Thomas McMahon, while employed afterwards in the extension of the land shaft, had his ankle broken, which was the only serious accident that occurred to any one whilst employed on the work. It was not considered necessary to have a special inspector for the regular mining shift, this being generally left to Mr. James Brown, the contractors' foreman.

TUNNELLING FROM LAKE SHAFT

The work of tunnelling was carried on from this end in very much the same manner, and about as rapidly as it was on the first 2,000 feet from the land shaft. The average progress made was 9½ feet a day till a point 2,290 feet from the lake shaft was reached, when operations in this direction ceased. When the work from the land shaft was within 1000 feet of the same point, it was thought best to stop the masonry there and run a small timbered drift through to the east face to be certain as to how the lines were going to meet. The two faces were brought together on the 30th of November, 1866, when it was found that the masonry at the east face was only about 7½ inches out of the line from the west end. The horizontal measurements were only three inches longer than was estimated by triangulation. This result, considering the great difficulty of getting a clear atmosphere in the tunnel, was deemed very good, and much better than was generally expected. The last of the masonry in the regular tunnel, when the two faces were brought together, was completed on the 6th of December, and a stone commemorative of the event placed there by the Mayor of the City in the presence of the City Council and Board of Public Works, both of which bodies, together with a number of citizens, passed from the shore through the tunnel to the crib, and then by a tug to the city on that day.

The ventilation of the east end of the tunnel was effected by means of six inch tin pipes connecting with the furnace of the hoisting engine. The pipes extended to the end of the masonry. Occasionally, ashes from the furnace would stop the ventilation, which would soon be discovered at the face.

GATE CHAMBER, CONNECTIONS AND COMPLETION.

In December the work of filling up the chambers was commenced, and also that of connecting the tunnel with the pumping wells. Much had been done previously towards constructing a gate chamber between the the land shaft and the pumping wells. This was made 19½ feet exterior, and 16 feet interior diameter, and divided into five compartments, separated by walls 20 inches thick. The outer walls were first built on a boiler iron shoe or curb, and then sunk by excavating within. An old abandoned inlet gave a great deal of trouble by letting in water; and the boiler iron shoe, which was adopted for the sake of economy, proved more expensive in the end than a cast-iron one would have been. The foundations were on a bed of concrete, 24 inches thick, on which the footings of the exterior and division walls, all of brick were built. Through the bottom of each division wall, there were left rectangular gate openings, 3 feet wide and 5 feet high. The tops of these openings are 23½ feet below low water in the lake. In each opening a cast iron gate frame was built. The gates themselves are tapering. The frames were fitted with wedging grooves or ways projecting beyond the walls, just sufficient to free the gates when raised or lowered. It was hoped that the wedging grooves would allow the gates to be screwed down perfectly tight; but in practice they have given more trouble than was anticipated, and it is believed now that in making future structures of the kind for the city, if any should be required, it would be safer and better to put a gate on each side of the wall, so that the pressure of the water could always be used to keep the gate tight. The gates are operated by means of rods, stayed at intervals, and by screws with hand-wheels at the top of the walls.

The connection between the land shaft and the gate chamber was of precisely the same size and form as the main tunnel. The connections with the old and new pumping wells, and a partial one with the provisional or south pumping well as also about 180 feet of a provisional connection with the lake shore, are all 4½ feet interior diameter, and were tunnelled through soft clay, without any difficulty, except a little trouble in working under and through the piling beneath the old pumping well. The connection with the lake shore, or rather the old inlet basin, is to be used in case it should ever be necessary to suspend the supply through the main tunnel either to examine, cleanse, or repair it.

A temporary connection between the land shaft and the mouth of the old inlet was made by means of a timbered drift through the clay, and a brick well 4 feet interior diameter and 30 feet deep, provided with a curb built above the water on an iron shoe, held together by iron rods, and sunk by means of the same dredging apparatus that was used for sinking the curb of the new pumping well. Two wooden gates were left in the top of the curb just below the surface of the water. A small area, enclosing the well and the inlet, were coffer-dammed around as far as necessary to cut them off from the flow of the lake whenever desired.

The work of filling the chambers of the main tunnel, and the cleansing of that structure having been completed, water was first let into it on the 8th of March, 1867, when only the horizontal portion was filled, this precaution being taken to avoid too sudden a pressure on the masonry. By the morning of the 11th the shafts were filled to the level of the lake. For the purpose of ascertaining if any defective workmanship existed where cavities on the outside of the masonry had been filled in, the water was pumped out of the tunnel sufficiently to permit the Engineer and three representatives of the city press to go upwards of half way towards the land. Not a brick was observed to be out of its place or to have started. The party not being able to push their boat any further without great discomfort, returned, but were upset and left in total darkness about 600 feet from the lake shaft to which they walked. Had this accident occurred a mile out, it would have proved very serious if not fatal to most of the party, as the water was too cold to be endured long.

After the examination the tunnel was again filled, and on the 24th, about 4 p. m., the mouth of the old inlet was cut off from the lake. Immediately the pumps, which were not stopped at all, drew down the surface of the water at the mouth of the inlet upwards of a foot. For a moment, it seemed to some of the bystanders as if the tunnel would not perform its intended office, but the next instant the water began to bubble up beautiful and clear at the top of the well, and continued to do so till the temporary connection was no longer needed; when this most pleasing and unexpected feature of the works ceased to delight the public.

The formal celebration of the completion of the tunnel and introduction of pure lake water, by appropriate public ceremonies, took place March 22th, 1867. From that time to this there has been no cessation in the supply, except three times, when stoppages of a few hours by anchor ice occurred. The experience thus far gained in this respect is believed to be sufficient to show how to prevent the recurrence of such accidents.

Careful observations have frequently been made to ascertain the head required to deliver given quantities of water through the tunnel, and it is found to exceed in capacity the original estimates. No indications whatever of internal injury to the structure have yet been observed.

ESTIMATE AND COST.

The original estimate of the probable cost of the work was $307,552. The actual cost, including all preliminary and other expenses of whatever nature, chargeable to the Lake Tunnel, up to April 1867, was $457,844.95, made up of the following items, viz:

Engineering and Superintendence	$28,774.02
Printing and Advertising	375.13
Miscellaneous	6,250.93
Labor	2,006.20
Lumber	1,142.72
Piles	1,258.29
Hardware	53.85
Castings	597.55
Lake Shaft	12,629.80
(Gates and gate chambers of Lake shaft, not included in contract of Dull and Gowen.)	
Dredging for Crib	1,500.00
Tugs, for Board and Employes	6,718.17
Discount on Bonds	14,685.35
Opening Celebration	979.18
Dull & Gowen, Contractors	380,784.60
	$457,844.95

The original estimate was made when common labor was worth $1.25 a day, which up to that time had been considered a very high price. It was also made near the beginning of the war, before the difference between the values of gold and currency had much disturbed prices generally.

The original contract with Messrs Dull & Gowen to construct the tunnel, was for $315,139. The final settlement with them was for $380,784.60, including $27,420 for extras on the tunnel proper, and $41,225.60 for extras on the shafts, crib, and east and west extensions. In view of the prevalent feeling that the contractors must be very heavy losers by the work, a very liberal policy was pursued towards them in the settlement of extra claims, yet it was finally proved by the books of the contractors, that their profits were not less than $50,000. It should be mentioned, however, that they claimed to have made great sacrifices in the sale of private property at the beginning of their operations, when the bankers who had promised to loan them money refused to keep their promise, on account of the reported hazardous nature of the work, and the probable ruin it would bring upon the contractors.

Very soon after the completion of the land shaft, the contractors applied to the City Council for an increase of price, and also for monthly payments of 85 per cent., not only upon all work actually done and in place, but upon materials delivered on the ground. The original contract allowed but 75 per cent. upon work actually in place, and nothing on materials delivered but not in their permanent place. The increase of price was not granted, but the rest of of the contractors' request was, thus increasing largely their monthly payments, especially on account of the crib. on which they could otherwise have received nothing until after it was secured in its position. About a year before the final completion of the work, the contractors made a second application to the City Council for an increase of price, and an ordinance was passed granting them an increase on their contract of 60 per cent., or upwards of $189,000. This sum was considered very extravagant by the Board of Pub,ic Works, who had always felt, and continued to feel, that some allowance should be made, but also felt that the proper time to do it would be at the close of the work, when by a frank statement of the contractors, and exhibit of their books, their actual loss, if any, could be ascertained. The Mayor vetoed the ordinance, and no other of this nature has since been passed, although the contractors did make their third application after the completion of the work, but the actual exhibit of their books caused the committee to report against the measure.

From the statements and books of the contractors, the actual cost of the work they did, deducting profits, was not more than $330,500. The crib and outer shaft cost $117,500; the land shaft cost $12,000; the west extension and connection with the gate chamber, no part of the original contract, cost $,6000, leaving $195,000 as the cost of the tunnel proper. This being 10,567 feet long, made the cost to the contractors $18.45 per lineal foot. The original estimate of cost to the city was $13.-54. The usual prices paid during the work, for common labor, $2.00; masons,$5.00, and engine men, $3.00 per day; for brick, $14.00 per thousand, and cement, $2.75 per cask of 300 lbs.

GENERAL SUPERINTENDENCE AND CONSULTATION.

On the part of the contractors, the general charge of the work was taken by Col. Gowen, who was rarely absent from the city. Mr Dull was very seldom here, but was of much service to the firm by his counsels. These gentlemen persevered through great discouragements, not so much from the intrinsic difficulties of the work itself, as from injury to their credit by the reported risks they had to encounter; and from the appalling rise of gold, and consequently of prices, before they finished. Their final success was complete and very gratifying.

Under the Board of Public Works, the general charge was taken by the City Engineer, who visited the work daily at first, and afterwards several times a week. Erastus W. Smith, Esq., of New York, was consulting Engineer in all matters relating to the iron cylinders and gates. It was supposed at first that the shafts would have to be sunk by the pneumatic process. Mr. Smith believed, as soon as he was consulted on the subject, that this expense and trouble might be saved, and the event proved the correctness of his judgment. Mr. Smith aided the City Engineer in obtaining important advice from Mr. Webb, the eminent shipbuilder, and others, relative to the construction of the crib.

It should be said in this connection that, by the advice of Capt. Swift, before the construction of the crib was commenced, Col. Hartman Bache, U. S. engineer, was visited at his office in Philadelphia and consulted. He examined the plans of that structure and pronounced them entirely safe.

SCIENTIFIC AND OTHER ITEMS.

Connected with the construction of a work of this kind, there was necessarily very much of interest that cannot here be repeated. The journals of the day published many articles relative to the tunnel, some purely descriptive, some speaking favorably of the enterprise, and many unfavorably. Since its completion, visitors to the city who reside hundreds, and in some cases thousands of miles away, frequently say, "we watched the progress of your work with great interest." The Academy of Sciences of this city had representatives, Drs. Jewell and Andrews, who made numerous observations relative to the geological developments by the excavations for the tunnel. The result of these has already been published in different forms, in Silliman's and other scientific journals.

Observations on sound were frequently made during the progress of the work. The first distinct notice of anything of this kind was when the tunnel had been made one hundred yards from the land shaft. Just above the tunnel is a breakwater enclosing the inlet basin. The outside of the breakwater consists of round piles, placed one to two feet apart. The waves could be distinctly heard in the tunnel below, striking those piles through 60 feet of earth. The next observation was the passing of propellers and tugs, when the tunnel reached half a mile or more out. The different noises made by a vessel or engine passing overhead could be heard as distinctly through 30 or 40 feet of earth as on the surface of the water. It was considered a matter of much interest to determine how far sound could be heard through the clay. The miners thought it could not be more than 150 to 200 feet. In order to be certain, observations were made when the faces were 800 feet apart, and sounds of blows of iron on stone or iron in the clay, but not on the clay itself, could be heard with great distinctness. Whether the sounds passed through 800 feet of clay, or first through 30 feet of clay, then through 800 feet of water and then through 30 feet of clay, is a question—probably the latter.

It is believed that the acompanying drawings of different parts of the work will be understood without further explanation.

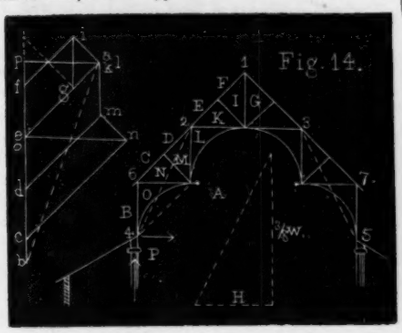
GRAPHICAL ANALYSIS OF ROOF TRUSSES.

BY CHAS. E. GREENE, A. M., PROF. OF CIVIL ENGINEERING, UNIVERSITY OF MICHIGAN.

V.

Another example where the horizontal thrust of the truss on the walls must be ascertained will now be given. The frame drawn in Fig. 14 is called a hammer beam truss, and is a very handsome type, often employed, in this country and abroad, for the support of church roofs, the braces being visible from below, and the spaces containing more or less ornamental work. When the church has a clear-story, the windows come between the trusses at B, the truss is supported on columns, and the roof of the side aisle takes up the horizontal thrust. If there are no side roofs, the main walls are properly strengthened by buttresses.

It will first be well to notice the fact that a curved piece in a truss, so far as the transmission of the force from one joint to another is concerned, acts as if it lay in the straight line between the two joints. The curved members in the present example are the quadrants of a circle. They may have any other desired curve, depending somewhat upon the pitch of the roof. If, now, we consider the point of support B P of the truss, and re-



member that the curved piece A O transmits the force between its two extremities as if it were straight, it will be evident that the thrust of this inclined piece must have a horizontal component which cannot be neutralized by a vertical supporting force alone. Therefore, in addition to the reaction of half the weight of the roof and truss, there must be supplied by the wall, assisted perhaps by a buttress or a side roof, a certain horizontal thrust.

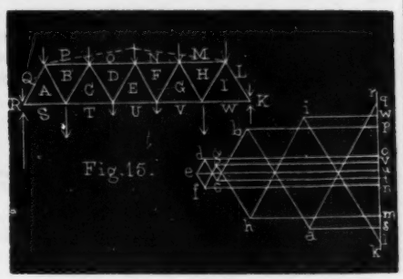
To determine the value of this thrust: — Let W= weight of truss and load. We have nine loaded joints, and there is, therefore, $\frac{1}{8}$W at each joint except the two extreme ones. Draw the dotted line from 4 to the joint 2, and the similar one on the other side. The whole truss may then be considered to be made up of a small triangular truss 1 2 3, carried upon a trapezoidal truss 4 2 3 5, the brace 4-2 being made up of an assemblage of pieces. As the load is symmetrically distributed, the trapezoid will require no bracing, (compare Fig. 13,) and L A will have no stress upon it. L A will be required when the wind acts upon the roof. Considering then the trapezoidal truss 4 2 3 5 alone, the joint 2 will carry a load equal in amount to that on D M, E K, and F I, or $\frac{1}{8}$W, the joint 3 will carry the same amount, while 4 will support $\frac{1}{8}$W from C N, and 5 the remainder. If, then, we lay off on a vertical line $\frac{1}{8}$W, for the load on 2, and draw lines parallel to 2-4 and 2-3 from its extremities, the line parallel to 2-3 will be the stress in the same, and will also, since the load is vertical, be the horizontal thrust of the foot of the compound brace 2-4. This force is marked H in the dotted triangle drawn below the truss. A reference to the trapezoid, Fig. 13, will aid one, perhaps, in understanding the above.

We have now the data needed for the stress diagram, of which one half only is here given. For the point 4, or B P, we have the upward supporting force $b\,p_1 = \frac{1}{2}$W; next $p_1\,a$, the horizontal thrust of the wall, etc., against the joint, $a\,o$ parallel to the line of action of A O, and finally, $o\,b$, the pressure of the post O B on 4. The resultant of $b\,p_1$ and $p_1\,a$, or $b\,a$, may of course be used for the reaction of the wall.

Entered according to Act of Congress, in the year 1875, by Charles E. Greene, in the Office of the Librarian of Congress, Washington.

Taking, next, the joint 6 we have $c\,b$, the load; $b\,o$, the thrust of B O, and we then draw $o\,n$ and $n\,c$. The joint C D gives $d\,c\,n\,m\,d$. The joint M A already has the lines $m\,n$, $n\,o$, and $o\,a$; since the line which is to close on m must be parallel to L M, and a is already vertically over m, $a\,l$ can have no length, and there is no stress on A L. Upon taking the joint D E we find also that no stress exists on L K. The reader must not think this fact at variance with the value H which was said to exist in 2-3 when we considered the trapezoid alone; the triangular truss 1 2 3 will plainly cause a tension in 2-3, and, with this distribution of load, such tension will exactly neutralize the compression caused in the same piece by 4-2. If one will consider the truss as loaded at 6, 2, 1, 3, and 7 only, thus doing away with N M, K I, I G, etc., he will find that a diagram will then give him some compression on K L.

It is sometimes the case that, in covering a large public building, it is desirable to have the interior clear from columns or partitions, while a roof of very slight pitch is all that is needed. Also, in a public hall, galleries may be suspended from the roof, and the weight of a heavily paneled or otherwise ornamented ceiling may be added to what the truss is ordinarily expected to carry. The trusses are then commonly made of timber, some of the parts in tension being iron rods. As it is not expedient to have a truss of much depth, one of several types of parallel chord bridge trusses may be employed, for instance, the "Warren Girder," of Fig. 15, which is an assemblage of isosceles, often of equilateral triangles. The depth might well be made less than here drawn, but, for clearness of figure, we have not made the truss shallow.



If the roof pitches both ways from the middle of the span, the top chord may conform to the slope, making the truss deeper at the middle than at the ends; but a light frame may be placed above, as shown by the dotted lines, and supported at each joint of the top chord, when we shall have the practical advantage that all the braces will be of the same length and the truss will be easily framed. If the roof pitches slightly transversely to the trusses, it will be convenient to make them all of the same depth and put on some upper works to give the proper slope. The ends of the truss could readily be adapted to a Mansard roof.

We have taken a case where each top joint is supposed to be loaded with the weight of its share of roof, in which case the joints L M or P Q will have three quarters of the weight on N O or O P, and where the bottom joints carry the weight of the ceiling, and in addition the tension of a suspending rod to a gallery on each side. The load line will be equal to the weight on the upper part of the truss, and the polygon of external forces will overlap, as in Fig. 11, previously explained. We go from r to k, for the load on the top joints in sequence, then up to w, then down to s, for the load on the bottom joints, and finally up to r again.

Upon drawing the diagram it will be seen that the stress is compression in the top chord and tension in the bottom chord; that the stresses in the chords increase from the supports to the middle; that the stresses in the braces decrease from the ends of the truss to the middle, and that alternate ones are in compression and tension, those which slant up from the abutments toward the centre being compressed, and those which incline in the other direction being extended. The tie-braces are, therfore, A B, C D, F G, and H I. A decrease of depth in the truss will increase the stresses in the chords.

Gen. Theo. G. Ellis, the well known civil engineer of Hartford, Conn, has been awarded the Norman medal by the American Society of Civil Engineers.

Mathematical Column.

PROBLEMS.

24. Given one side B C, the angles, and the area of an irregular quadrilateral field B D E C; to find the remaining sides, B D, B C, and C D.

S. P., Battle Creek, Mich.

25. A owned a piece of land, in form, a right-angled triangle, whose sides are to each other as 3, 4, and 5. He bought another triangular piece of B, adjoining, one side of which is the hypotheneuse of the right-angled triangle, and the other two sides measured 18 and 22 chains respectively, and the distance from the right-angle of the former piece to the opposite corner of the piece bought of B, measured 26 chains. How much land did A buy of B?

J. J., Whittlesey, O.

26. There are two circles tangent internally; One is 1100 feet and the other 800 feet in diameter. Suppose two horses were to start from the tangential point and go in opposite directions, one around the large the other around the small circle. After each had gone 1800 feet how far asunder would they be.

E. B. O., Pulaski, O.

27. Suppose we have a dam built across a creek thereby forming a pond the surface of water of which we wish to raise two feet, how much must the dam be raised to accomplish this. The dam is 10 feet high, 120 feet long, and the crest has the same section in both cases. The creek supplying the pond has a sectional area of 12 feet with a velocity of 40 feet per minute. A sluice of 1.5 x 1.5 feet is to lead out of the raised dam, 8 feet from the raised surface of the water.

V.

SOLUTIONS.

Errata, No. 12, Vol II, page 167.

For sin. (C−P), equation (4), read sin. (c−P).

For k (cos. A cos. P+sin. a sin. P), read

k (cos. A cos. P+ sin. A sin. P).

Equation (8) put cot. B for cot. C, in the denominator.

Line second from the bottom, for C, read c=49° 16′ log. 9.8146067

J. N.

17, Vol. II, No. 11, page 166.

Let C be the centre of the earth, 2 the summit of the mountain whose elevation is two miles, and 3 the summit of the one whose elevation is three miles.

It is evident that the line of sight 2 3 will be tangent to the circumference of the earth at some point between them. Assume this to be A.

Then we have the two right-angled triangles 2 A C, and 3 A C, and therfore

$$2\,3 = \sqrt{2C^2 - AC^2} + \sqrt{3C^2 - AC^2} = 279.91 \text{ mls.}$$

A LIST OF WORKS ON ENGINEERING AND TECHNOLOGY.

Geology, Manual of —; treating of the principles of the Science with special reference to American Geological History. James D. Dana. New York. 8vo, illus. $5.00.

Land, on the Reclamation and Protection of Agricultural —. David Stevenson. Edinburgh. 8vo. $2.25.

Locomotives, Notes on the Adhesion of. M. J. Moschell. Paris. 8vo. 1f

Mining Industry of the States and Territories of the Rocky Mountains, including descriptions of qnartz, placer and hydraulic mining; Amalgamation; Concentration; Smelting, etc. Rossiter W. Raymond, U. S. Com. of Mining Statistics, etc. New York. 8vo. illus. $4.50

Ornamentor, Modern—and interior Decorations. A. P Boyce. Boston, oblong. $3.50

Architectural Sketch Book, containing Plans of Churches, Railway Stations, Stores, Cottages, School-houses, Court-houses, Fountains, etc. Edited by the Portfolio Club, and comprising Designs by the most eminent Architects of New England. Boston. 4to. $6.50.

Architecture. Arrangement of Houses, considered in reference to sanitary and artistic requirements. Henry Maccormack, M. D. Belfast. 8vo. 25 cents.

TO INVENTORS.

We call the attention of Mechanical Engineers, Artizans, Patent Solicitors, and others interested in new inventions to the advantages for advertising offered by ENGINEERING NEWS. We will hereafter publish a list of new inventions reported for us each week by the well known Washington firm of Louis Bagger & Co, Patent Solicitors, and besides our regular mail list among the classes above named, we can guarantee to advertisers a distribution of a large number of extra copies each week among the machine shops of the whole country. Our advertising rates are very low, we have not the slightest personal interest in the business of soliciting Patent Office business, and our columns are open to all who wish to use. Send for our advertising rates.

ENGINEERING NEWS.

SATURDAY JANUARY 15th, 1876.

CEO. H. FROST, - Editor and Publisher.

168 Washington Street, Chicago, Illinois.

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UNITED STATES COMMISSION ON TESTS OF IRON AND STEEL

In our review of Engineering, printed in No. 1, we might very properly have noticed the important step taken in the appointment of the U. S. Commission on Tests of Iron and Steel.

An engineer, when called upon in the practice of his profession to design some structure or machine, makes use of certain formulæ to determine the proper proportions of the several parts. These formulæ are found in the various text and hand books, and contain certain constants, depending on the kind of material, mode of application of the force, form of cross-section, etc. They are either derived directly from experiment, or are deduced by theory from experimental data.

But there are many points on which it is extremely desirable that we should have fuller and more accurate information. We find that many of the experiments were made upon pieces of small length and section, in no way approaching the sizes in actual use. We do not possess exhaustive information on the relative strength of columns of various cross-sections. The use of steel will lighten any construction in which it is employed, thus rendering possible bridges or other structures of greater size. But we do not possess data for intelligent designing in this metal. Steel, in such abundance, is a modern article, and is a name which covers such a variety of products, that the distinction between different grades is not yet known. Chemical analysis is required in connection with mechanical tests. Then engineers can call for, and manufacturers can produce, the exact article wanted. The resistance of metals to simultaneous forces is also a very desirable object of inquiry.

But engineers are well enough aware of the need of more light without further assurance on our part. Extended and careful experiments would require much time and money, and would therefore be beyond any private purse. But the American Society of Civil Engineers moved actively in this matter, and, at their solicitation, an act of Congress, approved March 3, 1875, was obtained, appropriating the sum of $75,000, to be expended by a Commission in testing metals and in constructing a testing machine. Under this act the President appointed, March 25. Commander L. A. Beardslee, U. S. N., Lt. Col. Q. A. Gillmore, Engr. Dept., U. S. A., David Smith, Chief Engr., U. S. N., Wm. Sooy Smith, C. E., A. L. Holley, C. E., and R. H. Thurston, C. E., a board to "convene at Watertown Arsenal, Mass., for the purpose of determining, by actual tests, the strength and value of all kinds of iron, steel and other metals which may be submitted to them, or by them procured, and to prepare tables which will exhibit the strength and value of said materials for construction and mechanical purpose, and to provide for the building of a suitable machine for establishing such tests."

It is intended that the testing machine shall try the resistance of columns, as well as of rolled beams and built girders, of lengths and sections in actual use. The engineer will not then be obliged to generalize from the resistance of a small model where the fittings and construction will be likely to differ widely from what obtain in actual practice. To test beams and columns of large section, to ascertain carefully the elastic limit and the breaking strength, require testing machines of the best construction and of great power.

The names of the board are a sufficient guarantee that the work undertaken will be well done. A more definite idea of the field proposed to be occupied by this commission can be gained from a brief summary of the subdivisions of the investigation.

They propose to investigate and report upon:—

The abrasion and wear of railway wheels, axles, rails and other materials under the conditions of actual use; the mutual relations of the chemical and mechanical properties of metals; the corrosion of metals; the effect of variations of temperature upon the strength and other qualities of iron, steel and other metals; the character of iron best adapted for chain cables, the best form and proportion of link, and the qualities of metal for iron and steel wire ropes; the strength of armor plate, and to collect data from experiments already made; the laws of resistance of beams, girders and columns, to change of form and to fracture; the mechanical and physical properties of wrought iron, and of cast iron; alloys; the laws of resistance to simultaneous orthogonal strains; the physical phenomena of distortion and rupture; the effects of re-heating, re-rolling or otherwise re-working; of hammering as compared with rolling; and of annealing the metals; the constitution and characteristics of steels made by the Bessemer, open hearth, and other modern methods; the constitution and charictaristics, and the special adaptations of steels used for tools.

Such an extended series of experiments it can readily be seen will be very expensive, but the results obtained will be of great public benefit, as affecting all works of construction, by promoting the most advantageous and economical disposition of material. It is therefore to be hoped that sufficient appropriations will be made from time to time to carry the work forward to a successful conclusion.

Circulars have been distributed, setting forth the objects of the inquiry, and all persons who are in possession of experimental data, or who can furnish samples to be tested, are earnestly solicited to do so.

SPECIAL ADVERTISING.

Of the *necessity* and the *benefits* of advertising ones business, it is not necessary to enlarge here.

In these days of active competition in trade, the former is universally admitted, and of the latter we have too many prominent examples in this country alone, to require further argument on our part.

This is an advertising age. Every fence in city or suburbs is placarded; sign boards of every size and shape and exhibiting every grade of the painter's skill, hide the beauty, or add to the ugliness of our street architecture; men and boys parade the streets dressed in fantastic costumes, or encased in placarded boxes, or they stand at the corners and push circulars into the hands of every passer by; and all sorts of devices are paraded on wheels to draw the attention of the public to the fact that somebody has something to sell. Then there are the tons of circulars and cards that are daily being sent through the mails, to be deposited, after a brief glance, in the waste paper baskets of the country merchants. But all these methods, more or less valuable, are but secondary and insignificant beside newspaper advertising. In the great metropolitan dailies and weeklies every conceivable article of merchandise, or want of society, is advertised, and the sum total annually paid to all the newspapers and periodicals of the country is simply immense.

There is no way to advertise so cheaply or so effectively as by newspapers.

But it is necessary to exercise judgment in the selection of the proper journals in which to advertise. A manufacturer of locomotives will not use *Harper's Bazar* as a medium for seeking customers, even though that journal has a very large circulation; neither do the manufacturers of the country generally advertise in the leading dailies of the principal cities, although their circulation is immense. The English people are the most extensive advertisers in the world and we will do well to take a lesson from their practice. While their great dailies and weeklies are liberally patronized by the general public, there are a number of special journals whose advertising patronage is certainly a most enviable one. And none seem to be more popular than those devoted to engineering specialties. Before us is a late number of "*Engineering*" containing 32 large pages of advertisements; it is a medium for contractors, for civil and mechanical engineers seeking situations or having something to sell; all sorts of mechanical appliances from locomotives to boiler rivets, are advertised; there is road-making machinery, agricultural engines, cranes, dredges, pile-drivers, brick-making machinery stone crushers, tools, iron buildings, yachts, saws, patent rights, locks, stationery &c., &c.; advertisers find it a profitable medium through which to seek for business, and the editors and publisher make it their aim to produce just such a paper as will insure introduction to the very best class of customers for the goods advertised in its columns. Other papers pursue a similar policy, and so it has come about that special advertising in class journals is recognized as the most profitable of any method that can be adopted. American manufacturers have also begun to see the especial benefits of special advertising, and we now have class journals in almost every branch of trade that is of any consequence. The iron and coal trades are especially favored, and in the *Iron Age* of New York, and the *American Manufacturer* of Pittsburg, we have advertising journals that are not surpassed by those of any country in the world. The former has 40 pages, 13½×19 inches in size, of which 32 are either wholly or in part taken up with advertisements of almost every thing in the hardware and metal trades from an iron bridge to a carpet tack; while the latter has 20 pages of the same size, the most of which are taken up with a similar class of advertisements. In other branches of trade the value of special advertising is well recognized and the class journals are liberally patronized. And it is reasonable that it should be so. The business of the editors and publishers of these journals is to study the wants of the trade which they represent, and to minister to them. For this purpose they collect information from every accessible source; they are always eager for something that will be of interest or value to their patrons; they seek out new fields for trade, and collect the names of parties engaged in special branches; the interests of their advertising patrons are their interests, and it would be well if the latter would only recognize this fact, and encourage the former by a liberal use of the means offered them to bring their goods directly to the notice of the parties whose patronage is especially desired.

ENGINEERING NEWS is a class journal devoted to the interests of Civil and Mechanical Engineering, Mining and Manufactures. It has completed two full volumes, and is circulated in every state and territory in the Union. It has heretofore been published monthly, but henceforth will be issued weekly. For two years its publisher has labored to gain for it a good position among the first class journals of the country, and has paid but little attention to an advertising patronage, believing that the first essentials to success were character and a bona-fide circulation. These we can now guarantee.

ENGINEERING NEWS will be sent regularly to every Railroad Superintendent in America, and to the Boards of Public Works of the principal cities of the United States and Canada, the railways and cities being the principal purchasers of the greatest variety of goods, and the greatest employers of both skilled and unskilled labor. It will also go to the manufacturers of locomotive and stationery engines, car builders, bridge builders, contractors, civil, mining, and mechanical engineers, rolling mill proprietors, coal dealers, and to the whole class of trades that are more or less intimately connected with the construction of public works throughout the country.

For this large and intelligent constituency our paper will be edited with a care that must ensure its preservation and use as a book of reference. We shall endeavor to set up advertisements artistically and conspicuously, and by every possible method within our province as a publisher seek to advance the interests of our advertising patrons.

Our rates of advertising are placed at figures that will bear comparison with those of any other journal in the country, and will be furnished on application.

We invite you, then—business men and professional men—to examine our claims upon your consideration. Satisfy yourselves as to the real merits of our journal compare its facilities for advertising *your* specialties or *your* wants with those of other journals, and we have no doubts about the result. You will give our paper a trial, and you will become a permanent supporter and patron of our enterprise.

The New York, New Haven and Hartford R. R. Co. are preparing for the expected increase of travel during the Centennial by having twelve new passenger cars built at the Wason car works of Springfield, Mass.

ACADEMY OF SCIENCES.

ANNUAL MEETING.

The annual meeting of the Academy of Sciences was held on Tuesday evening, January 11th, at the rooms of the Association, No, 263 Wabash Avenue. Dr. H. A. Johnson presided, and there was a fair attendance.

The report of the Curator, Mr. J. W. Viele, was read. It showed the number of donations to the Academy since the December meeting as follows:

From Dr. Edmund Andrews, one specimen cinnabar or quicksilver ore; from F. D. Howell, Rochester N. Y., one opossum for a skeleton; from Dr. J. R. Silover; from Prof. E. J. Hill, Englewood, Ill., 6 specimens of plants; from J. N. Whitney, 4 specimens of crystallized salt from Great Salt Lake, Utah; from E. W. Nelson, one specimen of menobranches or water puppy.

From the Museum of Comparative Zoology, Cambridge, one illustrated catalogue of the Hester expedition; from the Department of the Interior, one copy cretacious vertebrata, E. D. Cope, 1875; from Prof. S. N. Winchell, Minneapolis, Minn.; one copy geological and natural history survey of Minn.; from scientific scientific bureau, Neulandvis, Haarlem, 7 pamphlets; from the Royal Institute Lombardo, des sciences, Milan, 27 pamphlets; from L. Yonne, one pamphlet; from Halle, 2 pamphlets; from the Imperial observatory, Prague, one pamphlet; from Regeneberg, 2 pamphlets.

The donations to the library of the Academy since the last annual meeting have been, bound volumes, 17; unbound volumes and pamphlets, 557; from the following sources:—

S. B. Buckley, Austin, Texas, Civil Engineers' Club of the Northwest, Gen. A. A. Humphreys, Department of the Interior, Philadelphia Academy of Natural Sciences, Smithsonian Institute. Marine Hospital Bureau, J. M. Woodworth, Washington, D. C., G. C. Broadhead, State Geologist Missouri, American Philosophical Society, Lieut. G. M. Wheeler, U. S. A., U. S. Naval Observatory Wash'n, Department of Agriculture, Wash., Chief of Engineers' Department, Wash'n, Prof. F. W. Putnam, Cambridge, Mass., Boston Society of Natural History, St. Louis Academy of Sciences, Cobden club, London, Eng., E. D. Cope, Philadelphia, Prof. S. W. Burnham, Geo. N. Lawrence, New York City, Entomological Society of Ontario, Chicago Relief and Aid Society, Museum of Comparative Zoology, Cambridge, Mass., Hon. Wm. Butterfield, Sec. of State, N. H., Essex Institute, Salem, Mass., American Association for the Advancement of Science, Am. Acad. of Arts and Sciences, Zoological Society of Philadelphia, Peabody Institute, Baltimore, Prof. Alexander Winchell, Mich., Buffalo Soc. of Nat. History, Prof. Fred. C. Hartt, U. S. Coast Survey, New York Lyceum of Nat. History, Bureau of Nav., W'n., Prof. E. T. Cox, State Geol. of Indiana, Prof. O. C. Marsh, Yale coll., S. H. Scudder, Belfast Naturalists Field club, Polytechnic Soc. Eng., Royal Geo. Soc. London, Eng., War Dept., W'n., Prof. S. N. Winchell, Minn., Baron Mueller, and a large number of foreign scientific societies.

The additions to the museum of the Academy since the last annual meeting have been as follows:

Mammalia, 11 specimens; birds, 112; reptiles, 28; fishes, 94; cretaceans, 1; mollusks, 130 species; fossils, about 1000 specimens; minerals, 136; skeletons, 7; plants, 6 specimens and one box unpacked; birds eggs, 1116 specimens; birds nests, 30; crustaceans, 18 species; echinoidea, 4; holothurians, 2; asteroidea, 2; corals 10; millespores, 1; coralines, 7; sponges, 5; archæology, 92 specimens; the Ward collection of casts, 800 specimens.

Dr. Andrews, of the Committee on Membership, recommended the admission of Mr. James Otis, and Mr. W. A. Stevens. These gentlemen were unanimously elected. The chairman then delivered a short address, reviewing the work of the Society during the year. In concluding, he said the friends of the Academy had been anxious not for its growth merely, but for its very existence. The courage and liberality of their trustees had provided a new building, and the confidence of scientific men and sister societies had filled it with valuable material. Their library was constantly receiving new and useful additions, and they only needed funds to provide for the care and display of what they had to make the museum not only attractive to the causal visitor, but to the student of science.

The election of officers was then proceeded with, and resulted as follows:

President— E. W. Blatchford.
First Vice President H. H. Babcock.
Second Vice President— Gov. Bross.
Recorder— Dr. Bridge.
Librarian— Dr. Viele.
Committee on Membership— Dr. Andrews, Messrs. Blatchford and Babcock.
General Committee— C. H. McCormick, Geo. C. Walker, B. Durham, A. Ebert, E. S. Chesbrough, J. H. Hollister; ex-officio members, Messrs Johnson, Blatchford, Babcock, and Bross.

Dr. Andrews then gave the substance of the following letter from James F. Bailey, Marion, Ga., — subject

"STORM PREDICTIONS."

MARION, AUG. 28th 1875

COL. J. W. LAPSLEY,

My Dear Sir:—Yours of the 5th inst. came to hand in due time and found me sick with fever; hence the delay in answering at an earlier date. I remember our conversation at the Exchange Hotel in Montgomery last spring, in reference to what you are pleased to term my theory relating to the winds, storms, &c. You say in your letter before me, that one matter, which impressed you especially was the theory recognizing the existence of a regular and well defined rain line, which I predicted, from certain data of which I then spoke, would probably extend through or near the regions intersected by the Ohio river during the summer. You ask me to give you a statement of my record or memorandum of the facts, relating to this matter, and upon which I have predicated my opinion that the primary cloud-orbit, on the continent, would develop in force along the Ohio Valley, during the summer months. Unfortunately I kept no record or memorandum relating to this matter; but having, on several occasions, during the past winter and spring, pointed out to others the prominent features of the then most remarkable cloud wave system I ever saw; and having noticed closely the lines along which, in terrific force, were developing the tornado, the cyclone, and the hail-storm, I could not but have indelibly impressed upon my mind the circumstances and conditions, the facts and phenomena pointing to the central line of the action of the primary cloud-orbit. As early as the 22nd of last Nov. the cloud wave had announced its line of action, when it burst with destructive fury upon Tuscumbia. After that time the winter's cold forced the line of rainfall further south, as evidenced by the storms and rains of March, which had their genesis in, and broke out of the piedmont of the great atmospheric ridge, formed along the meteorological tropic of Cancer. As the sun approached the summer solstice, the cloud wave receded and showed its line of operations on the north side of the Tennessee Valley; and finally, on the north side of the Ohio river. Well, you know the fact; but, if I understand you, you desire to know something of the principles and forces, from a knowledge of which you may be enabled, with a great degree of certainty or, at least, with a high degree of probability, to foretell the coming of important meteorological events, for considerable periods of time in advance of their occurrence.

These are some of the forces concerned in the development of the cloud wave. It is well known that the earth is an oblate spheroid; that its equatorial diameter is nearly twenty seven miles greater than its polar diameter; that this form results from the diurnal force, which occasions all matter in motion in north latitude to trend to the right: that is, a volume of the atmosphere, moving from north to south, will, because of its movement from less to greater circles, constantly find itself, more and more, to the west of the meridian of its departure; while another volume, moving from south to north, will, because of its movement from greater to less circles, constantly find itself, more and more, to the east of the meridian of its departure. In each of these cases, the atmospheric volume in motion trends to the right, by virtue of the diurnal force. You may ask what of bodies moving east or west? Why, manifestly, they will trend to the right in obedience to the diurnal force, in like manner as the bodies, moving north and south, trend to the right. If a body be moving from west to east, its velocity will be added to the diurnal velocity of the earth, and its tendency to bear to the equator will be increased to the extent of the velocity of the moving body; that is, it will trend to the right. But if the body be moving from east to west, its velocity will be subtracted from the diurnal velocity of the earth, and to the extent of the velocity of the moving body, the diurnal force will be set at rest, and the body will tend to the pole to restore the perfect sphericity of the earth: that is, it will trend to the right. To make the force of this law plain let me state a case, which will be approximately true. The mouth of the the Mississippi river is about two miles and a half further from the center of the earth than are its head waters. Now, if the diurnal force should be struck suddenly out of existence, the force of gravity remaining as it is, the river would reverse its course, and its waters together with the waters of the Gulf, would rush furiously back into the arctic seas. The equatorial heat and polar cold send back and forth from the equator to the pole, and from the pole to the equator, the great atmospheric volumes, which they put in motion. These volumes of moving atmosphere are so modified in their motion, by the action of the diurnal force, that they always pass each other by the left; that is, the volume coming from the north passes, to the west of the volume going from the south. These volumes of atmosphere, moving in opposite directions, and bearing apart by the diurnal force, produce the low wave, in which the cloud is formed. Now, the high waves, produced by the equatorial heat and polar cold, aided by the diurnal force, are brought down from their tottering equilibrium, by the interposition of the force of gravitation. Gravitation, then, curves the wind to the left, while the diurnal force trends the atmospheric volume to the right.

When I say that the movement of the cloud wave is orbital and rotary, I mean that its orbit is the result of the force of diurnal rotation and that its rotation on its axis is the result of the force of gravitation. Hence, I say that the right is the concave side of the orbit of a primary cloud, and that the left is the concave side of the winds. The genesis of the cloud wave is in the tropical regions and in the face of the northeast trade winds. It passes to the northwest obliquely across the face of these winds, until it reaches its meteorological tropic; it is then deflected towards the northeast, and it moves off in that direction until it is lost by diffusion.

What part is performed by magnetism and electricity in the development and operation of the active cloud, I am not prepared to state. I have not the philosophical appliances at my command, whereby to torture these elements into a revelation of the secret acts which they perform in the movement of the cloud wave, so I pretermit the expression of any opinion concerning their action.

The facts and phenomena, upon which I base my opinion, as to the distance, magnitude and direction of a cloud wave at any given time, are the following:—

1. The course, force, and the changing of the winds, through the points of the compass, and the length of time occupied in such changes. The cloud is always down the wind and on the left side thereof; and, as a general rule, it will be found in the first quadrant down the left of the wind. The distance of the cloud center will be indicated, by the length of time, occupied by the wind, in passing from south, round by west, to northwest and north, in case the cloud center is passing north of the observer; and if the time, so occupied, should be as much as four days, the center of the cloud, in that case, will hardly be nearer than the Ohio Valley. If a cloud be passing south of the observer, the wind will begin to blow from the north of east, and it will slowly change towards the north, rarely ever passing that point. Such changes as this take place in the colder months, and if the wind be strong, and changes suddenly to a point a little west of north, excessive cold may be expected.

2. The distance, direction and magnitude of any cloud, are indicated by the distinctness of the transmission of distant sounds. This is a new principle, not recognized by scientists; but it is ignored by them. My observations extending through a long period of time drive my mind to the conclusion that sounds cannot be transmitted with distinctness and intensity, through greatly extended space, unless they have their genesis far from the center of the nearest cloud wave, or, cloud basin. If sounds have their genesis at or near the centers of areas of high barometric pressures, or near the centers of areas of low barometric pressures, then they will be circumscribed in the extent and in the force of their propagation. If they occur at or near the centers of areas of high barometric pressures, they will be lost by lateral diffusion and dispersion. If they occur at or near the centers of areas of low barometric pressures, their volume and intensity will be maintained, but their propagation or prolongation will be circumscribed, or limited to the circumference of the atmospheric walls, in which they had their genesis. But if they occur within the periphery, or walls of atmosphere, surrounding a cloud basin of great extent, and, yet not near the center of that basin, then they will be prolonged down the wind on the concave side thereof, or to its left, with maximum intensity, and to the greatest extent possible under that meteorological development. On the morning of the 21st of Nov. last, the day before the Tuscumbia hurricane, the clicking and rumbling of the train, the ringing of the bell and the whistle of the engine, on the railroad from Greensborough to Newbern, were heard with astonishing distinctness, three miles southeast of Perryville, a distance of nearly forty miles. Mark the fact, that the storm was forming on the left of the segment of the atmospheric spiral down which the sound was transmitted so far and so distinctly.

In September, 1864, I wrote a short article, which was published in Jennings' paper in Selma, describing, as well as I could, the connection between the long transmission of sound and the form of the cloud wave; and among other things, I explained the phenomenon of the transmission of the sound of the cannon from Atlanta to Marion on the 22d of July, 1864, by stating that on the day named there was no primary cloud on the continent

east of the Rocky mountains and south of the lakes; and the conclusion was true, as the meteorological records coming into my hands after the war show; and yet this principle is treated with a contempt as profound as the ignorance which exists on the subject. I do not claim to be the originator of this view, because it was announced nearly three thousand years ago, as a prognostic of the coming cloud: *For there is a sound of abundance of rain.*" Here is a plain and absolute sentence; no exposition can make it clearer. Grave Bible scholars are at fault when they write an exegesis thereof; and science has not yet reached a stand point from which it can say, "Here is the meaning thereof." But I leave this disputed principle for some other occasion.

3. The *dip* of the cloud strata indicates the position of a cloud-wave on and below the horizon. Whenever you see stratified clouds spread along the verge of the heavens, if you will observe them closely and study them attentively, you will find much of order and regularity in their arrangement, and even beauty in their form and structure, which you may have considered mere confusion and an inextricable muddle. When the cloud strata are in sight there will be a point in the horizon towards which the strata will converge; and if the strata are prolonged across the face of the heavens, there will be another point in the horizon nearly opposite the first, but never exactly so, at which the strata will *apparently* converge. If there is any wind blowing at the time of observation, it will show you at once the real convergence of the strata, because it will always be on the left side of the wind, while the apparent convergence will always be on the right side of the wind: that is, the real dip of the cloud strata will be to the left of the wind, and this side is the rain side. Now, as you stand facing this point of convergence of the cloud strata you will see that the strata which go down from your right, will, at the point of convergence be masked by the strata which go down from your left. And, as you stand looking towards the convergence of the strata of the clouds, the wind will be blowing in from your left in such a manner that the point of convergence or dip of the cloud strata will be to the left of the wind. Now, my long experience is that this order of the dip or convergence of the cloud strata is never reversed; that this convergence is not apparent merely, (as is the one to the right of the wind,) but real; that this dip of the cloud strata is not an optical illusion but a reality; that the cloud striæ, which appear in the higher regions of the atmosphere on the approach or passage of a cloud are not tangential to the cloud basin, but that they dip down the barometrical gradient from the areas of high barometer, where they float like gossamer films on the borders of calm, clear weather, towards the areas of low barometer cumulating as they descend, until they are lost in the cumulus, the nimbus, and the scud-clouds of the cloud basin. It is by the observance of these phenomena, and their constant relation to each other that I am enabled to locate a distant cloud. Even before any disturbance has taken place in the atmosphere at the surface of the earth, even before the meteorological instruments have ceased to vibrate to the going wave, the long fine filaments of cloud that stretch across the heavens and dip down to the horizon in an unmistakable crossing, will have pointed out the position of the coming cloud basin in the cloud orbit, whether it be one hundred or one thousand miles distant.

I have hurriedly written this in answer to your letter. I will add that the cloud in its orbit within the tropics, poured down floods upon Cuba; it then made its meteorological tropic in the western gulf, and then, passing on to the northeast, with increasing rains, it crossed in succession northern Texas, north Louisiana, Arkansas, southeast Missouri, and then, crossing the Mississippi river between St. Louis and Cairo, the line of heavy rainfall traced the north branches of the Ohio river to its sources, and then passed over Pennsylvania, New York and the New England States, and on to the northeast.

I would be pleased to have an opportunity to explain verbally, and with the use of diagrams and maps the principles herein referred to. I think I could by that means make myself understood by intelligent, educated men. Very respectfully,

Your Obedient Servant,

JAMES F. BAILEY.

PAPERS.

An interesting paper was read by Dr. Andrews on the "Recession of St. Anthony's Falls, Minneapolis," which have receded 1,500 feet since Hennepin first set eyes upon them. As the result of observations made some time since on the lake shore he had been led to think that the time usually allowed was far too great, and that it could not much exceed eight thousand years. Recently he had obtained another set of observations from the reports on the work at St. Anthony's Falls, and by correspondence, which strengthen that opinion. The river at the falls flows over a blue limestone from 40 to 50 feet thick, under which is a softer sandstone. Owing to the superior hardness of the limestone, this water washes out the sandstone from under it, until it breaks and falls, when the same process commences again. The government works to protect the falls have been undertaken because it has been discovered that the stratum of blue limestone extends but a few miles above Minneapolis, and that above that the bed of the river is much deeper. Before the Tertiary period there must have been a Mississippi river, and it is probable that above St. Anthony's Falls, where the channel is deeper, we find the old bed of the Mississippi. It is supposed that the cataract commenced its work after the drift period, at a point five miles below St. Paul's, or 23 miles below its present position, since the river runs between bluffs for that distance.

One hundred years ago Father Hennepin traveled up the river, and he, or some one of his party made a sketch of the falls as then situated. This sketch shows an island, supposed to be Spirit Island, which is now 1,500 feet below the falls. During the past 26 years, owing to the improvements for water power purposes being made at Minneapolis, the erosion has been 500 feet. Taking off this 500 feet we find the rate of erosion for the remaining 75 years, was at a rate of about 13½ feet a year, and that it has taken about 9000 years for them to recede that distance. It is possible that 15 instead of 13½ feet should be taken as the average yearly erosion, since the volume of water flowing in the river was formerly much more than at present. We may conclude, therefore, that 9000 years is a sufficiently long period to allow for the time which has elapsed since the drift.

The Academy then adjourned.

IRON PULLEYS AND LEATHER BELTING.

BY JAMES R. WILLETT, ARCHITECT.

Having had occasion to put up some iron pulleys and leather belting, recently, I was not able to find any practical rules on the subject of belting condensed as much as desired. I therefore offer the following as the result of my examination, in such a shape that it can be readily used by the practical man, laying no claim to originality in the subject matter, or to a strictly scientific treatment.

The formulæ for calculating the speed of pulleys are well known, and I merely recite by way of introduction, that, where

D=the diameter of the driving pulley;
N=number of revolutions per minute;
d=diameter of driven pulley;
n=number of revolutions of the driven pulley per minute.

(1) $$d\,n = D\,N$$

(2) $$d = \frac{D\,N}{n}$$ (3) $$n = \frac{D\,N}{d}$$

(4) $$D = \frac{d\,n}{N}$$ (5) $$N = \frac{d\,n}{D}$$

There are four quantities in these formulæ, in order to find one of which the other three must be given or assumed.

These formulæ may be put into words as follows:

1. The diameter of the driving pulley multiplied by the number of its revolutions per minute is equal to the diameter of the driven pulley multiplied by the number of its revolutions per minute.

2. *To find the diameter of the driven pulley:*

Multiply the diameter of the driver by the number of its revolutions per minute and divide the product by the number of revolutions of the driver.

3. *To find the number of revolutions of the driven pulley:*

Multiply the diameter of the driver by the number of its revolutions per minute and divide the product by the diameter of the driver.

4. *To find the diameter of the driving pulley:*

Multiply the diameter of the driven pulley by the number of its revolutions and divide the product by the number of revolutions per minute of the driver.

5. *To find the number of revolutions of the driving pulley:*

Multiply the diameter of the driven pulley by the number of its revolutions per minute and divide the product by the diameter of the driver.

BELTING.

The readiest and most reliable way of calculating the power of belting I found to be as follows:

Let T—*the strain given in the following Table 1 at the given (or assumed) arc of contact with the shortest pulley.*

W—*width of belt in inches.*

V—*velocity in ft per minute.*

H—*horse power.*

Then $H = \frac{W\,V\,T}{33{,}000}$ that is

6. *To find the horse power a belt will transmit:*

Multiply together the width of the belt in inches; the velocity of the belt in feet per minute, and the tabular number given in the Table 1 corresponding to the given (or assumed) arc of contact of the smallest pulley and divide the product by 33,000 the quotient will be the horse power.

TABLE 1.

Strains transmitted by belts one inch wide corresponding to different arcs of contact.—(*From Journal of the Franklin Institute, 1868, by Briggs & Towne.*):

ARC OF CONTACT ON SMALLEST PULLEY.			Strain in lbs for belt one inch wide.
In vulgar fractions of the circumference.	In decimal parts of the circumference.	In degrees.	
1/4	0.250	90	32.3
5/18	0.278	100	34.8
11/36	0.306	110	37.1
1/3	0.333	120	39.2
3/8	0.375	135	42.1
5/12	0.416	150	44.6
1/2	0.500	180	49.0
7/12	0.583	210	52.5
2/3	0.667	240	55.3
3/4	0.750	270	57.6

The strains given in the table give a margin of 25 per cent additional strength. If necessary these figures can be reduced that amount.

The arc of contact can be exactly obtained by making a drawing showing the relative size and position of the pulleys. It can sometimes be assumed near enough for practice by a knowledge of a relation of the pulleys. Sometimes a protractor may not be at hand so that the arc cannot be readily measured in degrees; I have therefore given the portions of the circumference, compared with the circumference of smallest pulley, (corresponding to the angles); these can be got by measuring on the drawing.

If it is desired to get the necessary width for a belt to transmit horse power, the formula becomes

$$W = \frac{H\,33{,}000}{V\,T}$$ that is

7. *To find the width of a belt:*

Multiply the horse power by 33,000 and divide this product by the product of the velocity in ft per minute multiplied by the tabular number.

The velocity of the belt is the same as the velocity of the circumference of either of the pulleys if there be no slipping; the circumference of the driver and of the driven pulley are running at the same velocity, and as the belt connects the two they must all run at the same speed.

The formula for the velocity in feet per minute is as follows, where

C—*circumference of the driving pulley.*

c—*circumference of the driven pulley.*

(And the other letters as before.)

$$V = N\,C = N\,D\,3.1416$$

or $$V = n\,c = n\,d\,3.1416$$

That is

8. *To find the velocity in feet per minute:*

Multiply the number of revolutions per minute of either pulley by the circumference of that pulley, or

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Multiply the number of revolutions per minute of either pulley by the diameter of that pulley and also by 3.1416.

The following empirical formula gives results which I have found to be nearly correct, it is easily remembered and requires no tables. It may be found advantageous as a guide for getting the general proportions of a work which may afterward be correctly calculated. The arc of contact with the smallest pulley is supposed to be about 150°

$H = \frac{W V}{750}$ that is

9. To find approximately, the horse power which a belt will transmit:

Multiply the width of the belt in inches by the velocity of the belt in ft. per minute and divide the product by 750.

To find the necessary width of a belt to transmit a given horse power, this formula becomes

$W = \frac{H\ 750}{V}$ that is

10. To find, approxmately, the width of a belt in inches required to transmit a given horse power:

Multiply the given horse power by 750 and divide the product by the velocity in ft per minute.

The foregoing rules relate the adhesion of the pulley to the belt, or in other words the prevention of slipping, but do not bear on the subject of the strength of the belt and its ability to bear the strain without breaking.

The strength is usually got by giving the belt sufficient width, and to find the proper width this formula, although not always strictly correct, will be sufficiently so for practical purposes:

$$W = \frac{H\ 33{,}000}{V\ M}$$

Where

M = 33 for single thick belting, laced at joint.
= 60 " " " " spliced " "
= 40 " double thick " laced " "
= 75 " " " " spliced " "

(The other letters the same as before.)

Where practicable, it is best to use single thick belting spliced at joint.

Pulleys should be slightly wider than the belt.

Belts with the grain side to the pulley will do more work and last longer than if used with the flesh side to the pulley.

Belts will do more work when the pulling side of the belt is underneath.

These rules will give larger sizes than are ordinarily used, but I am satisfied that the results are correct. Generally the pulleys that are used are too small and not unfrequently much too small. This is often the reason that belts give way and wear out so fast. If a belt is running, say 1,000 ft per minute, which is a low velocity, and it slips but 10 ft per minute, the grinding action will wear out the belt. It often is the case that a belt will slip from 25 to 100 ft per minute when running at a high velocity, and of course the belt cannot wear long at that rate, besides the slipping causes irregular and injurious action.

I was consulted in a case where complaint was made of the frequent giving way of the belt from the engine pulley to the main shaft and of the irregular action of the machinery. On examination I found that the engine pulley was something less than one half of the proper dimensions. We put on a new pulley double the diameter of the old one and a trifle wider (and of course a pulley on the main shafting to correspond), also a spliced or endless belt. It has now been running in the most satisfactory manner for about two years and has never given the slightest trouble, nor is there any apparent wear on the belt. When the pulleys and belts are of the proper size the face of the pulley will be clean but not polished. Whenever a pulley face has a bright burnished appearance, it shows that the belt is slipping. When the velocity of a belt is over 2,000 feet per minute an additional allowance ought to be made in the case of small pulleys.

These rules apply when the belts are kept strained somewhat less than is usual in shops, where the belts are not unfrequently overstrained in order to be able to do any work at all (on account of the insufficient size of the pulleys), to the damage both of the belt, of the shafting and of the journals.

If the faces of the pulleys are covered with leather it will increase greatly (from 25 to 40 per cent) the resistance to slipping.

FORGINGS.

The importance of good forgings in engine-machinery cannot be properly estimated except by those who have been intimately connected with engine-making. All the working portions of an engine that are intended to sustain the greatest strain must be forged. A few years since engineers used cast iron for such purposes, and in order to obtain sufficient strength, made use of large masses of metal; thus ensuring a certain, or rather uncertain, amount of safety. However large a lever or shaft may be, there is always attending it some disagreeable apprehension of danger, if it is made of cast iron, and the suddenness of the break is almost certain; but, with forged iron, an instantaneous break, without some sign of approaching rupture, is extremely rare. Such a division may possibly occur if the shaft, lever, or rod is made too small; and there is also a small liability to such an occurrence with shafts that are too large. A well-proportioned forged shaft or lever may be so much injured by improper hammering as to render it liable to break with less than the ordinary wear and strain allotted to it. Good soft iron, of well-defined fibrous character, may, by hammering, be made crystalline, and will become as untrustworthy as the cast iron from which it was originally made.

The outside dimensions of a forging often convey an incorrect idea of its internal strength; and no engineer, however penetrating, can, by measuring a certain shaft or lever, ascertain whether it is strong enough for the engine of which it is a part; neither can he point out its weakest spot. The smith who made it should know much more about the strength of his forging than any other inspector; but smiths generally do not know. A good smith is a rare individual. He knows that the fibres of the iron must be so arranged as to be in proper position for sustaining the strain; and having succeeded in obtaining a proper arrangement of the fibres, he will not change them into crystals by improper hammering.

A smith is a much more important individual than a member of any other branch of engine-making. Planers, fitters, and turners are more dependent upon mechanical contrivances than smiths. An intelligent turner can very soon learn all that is needful for his business; but a good smith is more original and prescient than a member of any other branch. Much more time is required to make a good smith than to make a good planer or turner.

It is, however, proper to admit that the engine-smith of the present day is not generally so original or ingenious as the smith of olden time. An inferior smith can now produce good work in large quantities, in consequence of the great aid afforded him by various inventions for reducing the amount of labor, these inventions being the productions of studious mechanical men who are not neeessarily smiths in the usual meaning of the term; but by placing a modern smith upon an equality with one of old, without recent inventions, we discover the amount of ingenuity in each.

Probably in a few years the forging process will become quite as mechanical as planing, slotting, or turning, at which time the present foresight, skill, and labor accompanying forging will be almost dispensed with; but until forging machinery becomes general, the smith must continue to exercise his present amount of care, discretion, and skill.

The number of forging machines is at the present moment very considerable, and some of them produce better work than can be made by any kind of mere hand labor, unless an intolerably large amount of time is consumed during the process. We now have a variety of machines for producing forgings by compression, bolt-machines, nut machines, a great number of rolling machines, and a variety of steam hammers. All these are daily becoming more intimately associated with smith's work of all kinds, large and small. Even at the present time, all those forging machines that act by compression and cutting dies, can be adapted to produce all the necessary forgings for small engine-work, and we may reasonably expect to obtain machines each more and more varied in application than the preceding; and the works produced will be more and more the result of machinery, till the smith's hand-labor and intellectual energy now required for his work be reduced to a minimum. Probably, at the time the minimum of labor is reached, we shall reach the maximum of good quality. By referring to other branches of engine-making, such as turning or planing, we discover that every mechanical contrivance introduced to diminish labor, at the same time increases the good quality of the work produced. We may thus infer that similar things will occur in the noble art of forging.

The advantage of a tolerable knowledge of smith's work to engineers is hereby made apparent to readers generally; some remarks may therefore be submitted to students who wish to acquire some knowledge of the internal structure of the various pieces of machinery and not merely how to shape their outsides.

Although we know that mechanical contrivances will become more and more extensively applied to forgings of all kinds, we do not anticipate any change in the circumstances that determine or control the production of good, sound work.

With relation to a good piece of smith's work, three principal circumstances require consideration. These are the outside dimensions of the article when finished, the arrangement of its component fibres, and the amount of wear and tear to which the article will be subjected when in ordinary use.

The outside dimensions of a forging are ascertained by ordinary calculation, after it is decided to what purpose the engine, machine, or lathe is to be applied.

JAS. R. WILLETT,

ARCHITECT,

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